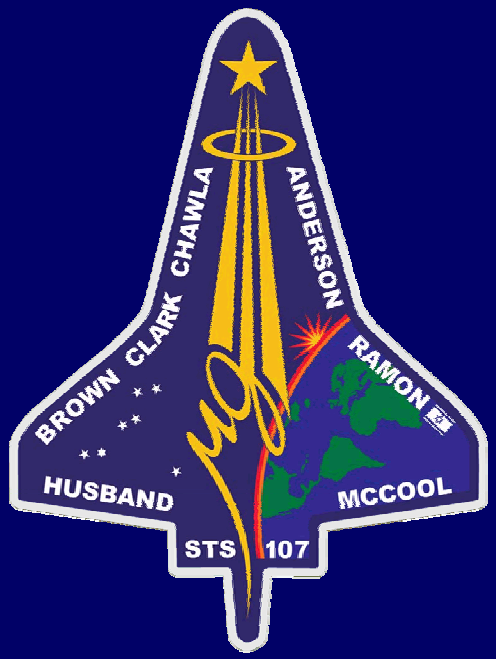
Learning from the Space Shuttle Columbia Accident

Columbia Accident Investigation Board



Major General Ken Hess
Air Force Chief of Safety

Why am I here?

- **Lessons Affirmed from history**
  - **Apollo 1, Challenger, Bhopal, Concorde, Chernobyl, USS Thresher**
  - **All Managerial Primers**
  - **Lessons Never Learned**
- **Effective Safety Leadership demands more than sound bites**

Columbia Accident Investigation Board

Briefing Overview

- **Causes of the STS-107 Mishap**
- **STS-107 Mission Summary**
- **The Accident, What Happened**
- **What Can We Learn from STS-107**

Cause of the STS-107 Mishap

- **TECHNICAL CAUSE:**
  - Breach in the Thermal Protection System on the leading edge of the left wing

- **ORGANIZATIONAL CAUSE:**
  - SSP History and Culture
  - Original Compromises due to:
    - Years of Resource Constraints, Fluctuating Priorities, Schedule Pressures, Confusion over Operational Vs. Developmental, Lack of National Vision
  - Cultural Traits:
    - Past success, Communication Barriers, Lack of Integrated Management Structure, Informal Chain of Command

STS-107 Mission Summary

- STS-107 was the 113th mission in the Space Shuttle program and Columbia's 28th trip into space
- STS-107 was launched from Kennedy Space Center, Florida on January 16th, 2003 for a 16 day science research mission

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Launch & Ascent Debris Strike

View Full Screen

Launch Animation

Post-launch film analysis indicated foam from the left external tank bipod ramp area impacted *Columbia* near Reinforced Carbon-Carbon (RCC) Panel 8 81.9 seconds launch on January 16, 2003

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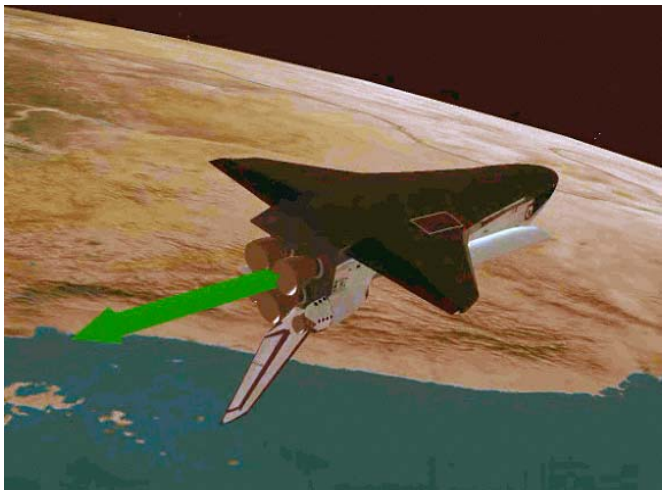
What Can We Learn From The Columbia Accident?

- **Blind spot born of success:**
  - **Lapse in Leadership, Communications, Process Controls**
  - **Safety and Engineering processes “infallible”**
  - **Lost Checks and Balances; Informal Decision Making**
  - **Cost/Schedule vs. Reliability**
- **Unjustified Optimism**
- **Result: foam strikes “normal”; schedule pressure; Eight Opportunities Missed**
- **The Faustian Bargain vs. F-B-C**

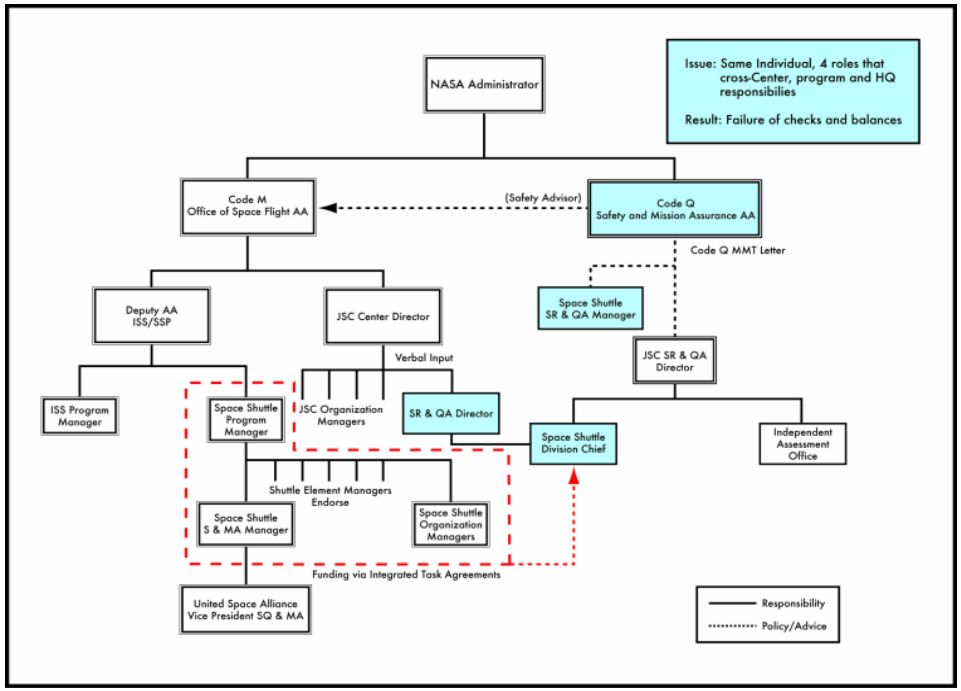
What Can We Learn From The Columbia Accident?

- **Weakness of a Matrixed Organizational Structure**
  - Promoted Uneven Division of Mission and Responsibility
  - Engineers and Safety Services "Bought"
  - "Contracting Out" Made Organization more Efficient, but Blurred Line Between Gov't Oversight and Contractor Performance
  - Can Lead to Distributed and Dispersed Decision Making



What Can We Learn From The Columbia Accident?

- **Dangers of a Matrixed Organizational Structure (Cont'd)**
  - Key Capabilities and Technical Expertise Lost to Contractor
  - Information Filtered Before Reaching Decision Makers
  - Badge equaled Credibility



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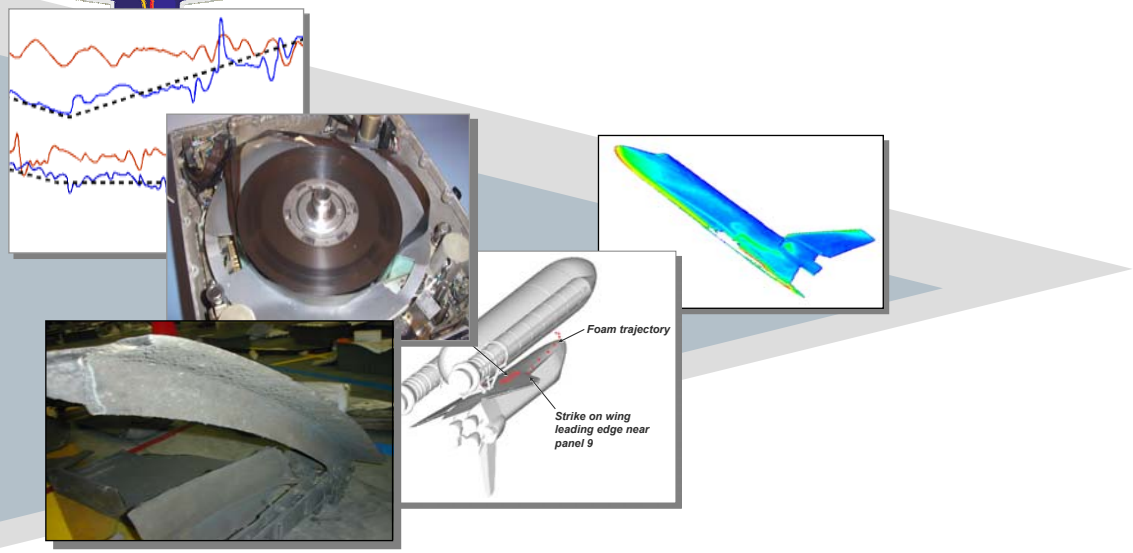
What Can We Learn From The Columbia Accident?



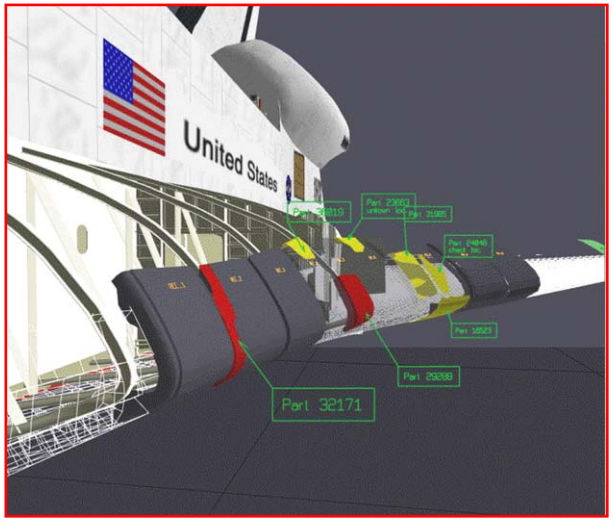
- **Columbia Accident Can Be Characterized By:**
  - Flawed Analysis
  - Low Management Concern
  - Divergent Views Between Management and Engineering
  - “Prove it’s Unsafe” Mentality
  - Truncated Thinking: Was Columbia in Trouble and In Need of Help?

What Can We Learn From The Columbia Accident?

- **Organizational Context of Risk**
  - Space Shuttle Never Risk Free
    - "Accept Risk" That Couldn't Be Quantified by Testing or Experience
  - Deviation from Expected Performance …"In Family"
  - Risk Process Converted Controversy, Negotiation, Risk Estimates and Toleration of Deviations into ***Binding Institutional Facts***

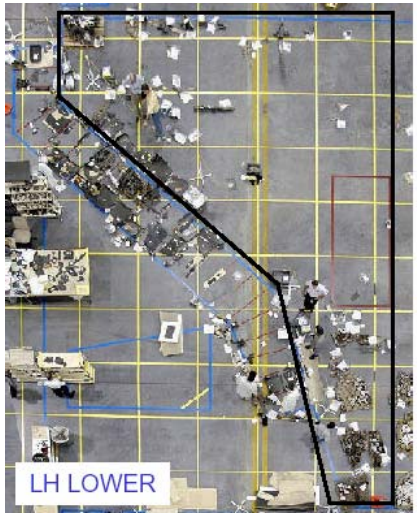
What Can We Learn From The Columbia Accident?

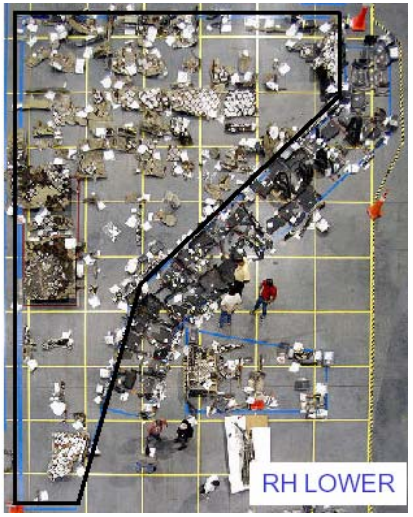
- **Organizational Context of Risk (Cont'd)**
  - "Accepted Risk" was Determined by Matrixed Work Groups
    - Negotiated Differences of Opinion, Built Consensus, Erased Ambiguity
  - Readiness/Certification Process Valued Consensus
    - Uncertain Became Certain
    - Secrecy, Culture of Production, Politics, Economics Reinforced these Processes
  - Anomalies No Longer Viewed as Danger Signs
  - Weak signals lost
  - PowerPoint substitute for technical papers
  - Get what you inspect, not what you expect



What Can We Learn From The Columbia Accident?

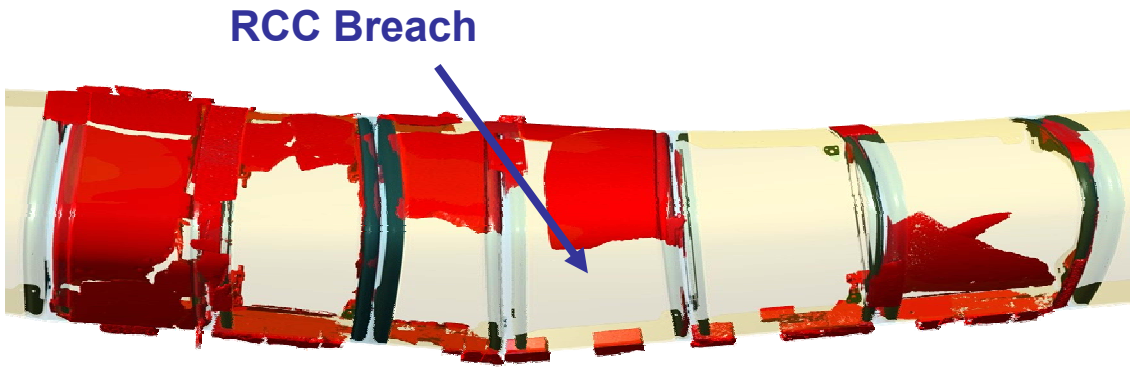
- **How an Organization Responds to Anomalies will Depend on the Organizational Context of its Work**
  - Consequences of Failure High, Demand for Reliability Goes Up
  - Gov't Entities such as NASA Cannot Readily Adapt Corporate Processes due to Unique Work





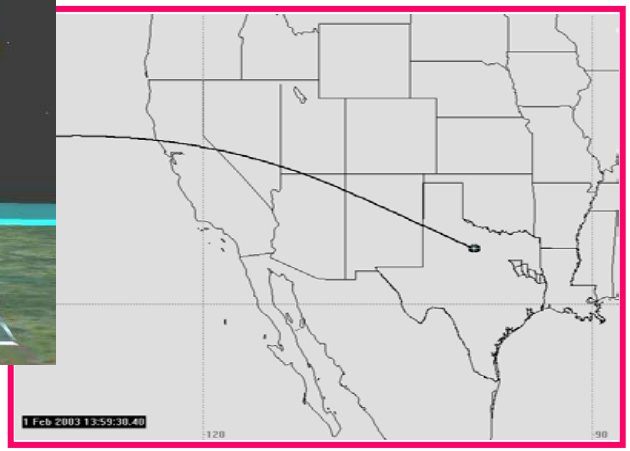
What Can We Learn From The Columbia Accident?

- **Accident Response**
  - Investigations Focus on Finding Direct Cause and Blame
    - Personal Error
    - Widget that Broke
  - Complex Organization Accidents Require Deeper Analysis
    - Organizational and Institutional Factors—system effects



What Can We Learn From The Columbia Accident?

- **Accident Response (Cont'd)**
  - CAIB Took a Broad Look, no Attempt to Excuse Personal Accountability
    - Chap 5: Political and Economic Environment, Strategic Decisions
    - Chap 6: Decision Making and Actions
    - Chap 7: The Organization: Gap Between Perception and Reality
  - Report Found Cultural Problems in Each Layer of the Organization



What Can We Learn From The Columbia Accident?

- **Implications**
  - People get Engineered by the Environment and Will Act in Ways Consistent with organizational norms
  - Structure and Culture are Connected
    - Structure: The Operating Rules
    - Culture: Whether or not Rules are Followed
  - Structure, Hierarchy and Power Affect Risk Decisions

What Can We Learn From The Columbia Accident?

- **Implications (Cont'd)**
  - Problems can have Long Incubation Periods
  - Changing Personalities won't fix Problems in the Organizational System
  - Given enough time any organization can become desensitized
  - Organizational structure can add unseen risk
  - Group think happens

Bipod Foam Loss from STS-112

What's a Leader to Do?

- Provide vision
- Don't compromise principles
- Leadership is "theater"
- MBWA—what's really going on
- Learning Organization—past mistakes
- Communicate
- Checks and Balances

"This cause of exploration and discovery is not an option we chose; it is a desire written in the human heart... We find the best among us, send them forth into unmapped darkness, and pray they will return. They go in peace for all mankind, and all mankind is in their debt."

—President George W. Bush, February 4, 2003

Backup Slides

Columbia Accident Investigation Board

STS-107 Crew Members

Rick Husband
Colonel, USAF
Commander

William McCool
Commander, USN
Pilot

Kalpana Chawla, Ph.D.
Flight Engineer

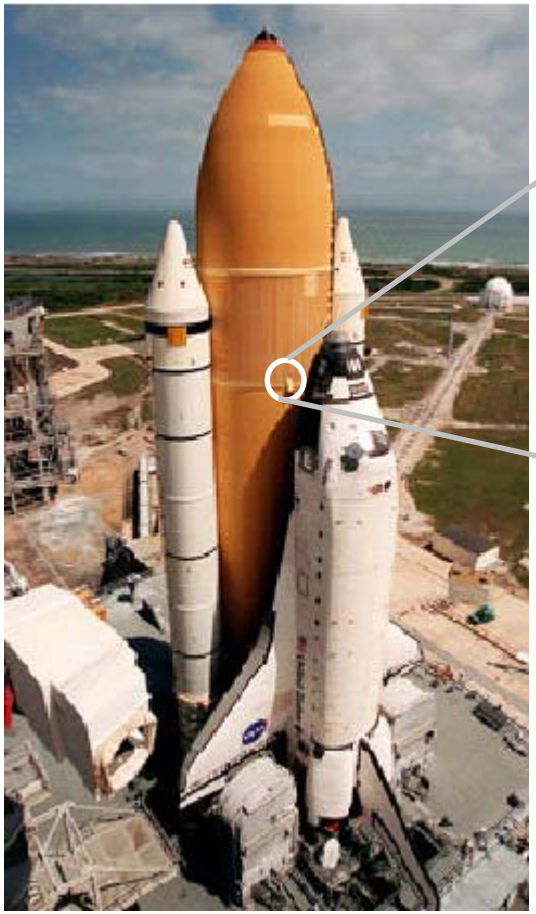
Laurel Clark
Commander, MC, USN
Mission Specialist

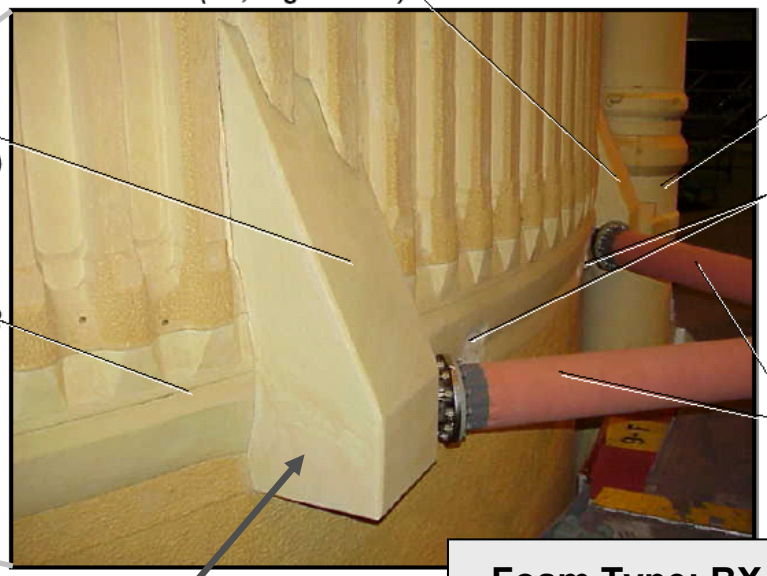
David Brown
Captain, MC, USN
Mission Specialist

Mike Anderson
Lieutenant Colonel, USAF
Payload Commander

Ilan Ramon
Colonel, Israeli Air Force
Payload Specialist

Bipod and Flange Area Overview





Foam Type: BX-250
Density: ≈ 2.4 lb/ft³

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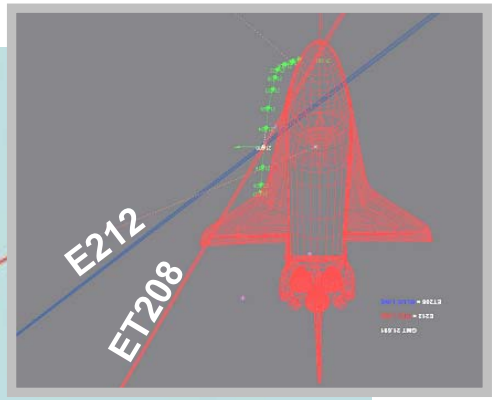
Camera Angles During Launch



E212 film
Top-side view of Shuttle

View Video

ET208 video
E208 film (blurred)
Bottom-side view of Shuttle

View Video

Launch Cameras

1	40 sec. MET
2	50 sec. MET
3	60 sec. MET
4	70 sec. MET
5	80 sec. MET
6	90 sec. MET
7	100 sec. MET
8	110 sec. MET
9	120 sec. MET